Fermilab
PPD/MD/Engineering Analysis Group

A Comparison between the Test data and FEA Calculation for A Single PVC Panel

Ang Lee
July 21, 2004

Victor Guarino's (ANL) group has recently done a single panel buckling test with a commercial PVC extrusion. The Figure 1 is a test apparatus picture, taken by Vic Guarino. The test sample has a dimension 27" high by 24" long with 26 cells. The cell profile is 1" x 1 5/8" with 1/16" thick (side wall) and 1/32" (rib). The test, as indicated by Vic's, shows a collapsing load Pcr=208 lbf.

Based on the information provided, three calculations have been done to compare with the experiment data. The first one is a 2-D buckling model by using a plane element. The second one is a 3-D model with a thin shell element. The third one is an analytic solution. The comparison is summarized on Table-1.

Table 1 The Comparison Between the Test Data and Calculation Result

	Vic's Test Data	FEA 2-D model	FEA 3-D model	Analytic Solution
Collapsing Load (lbf)	208	199	193	180
Difference with test data (%)		5%	7%	17%

Figure 1 The test piece for a commercial PVC panel
(Picture is taken by V.Guarino (ANL)

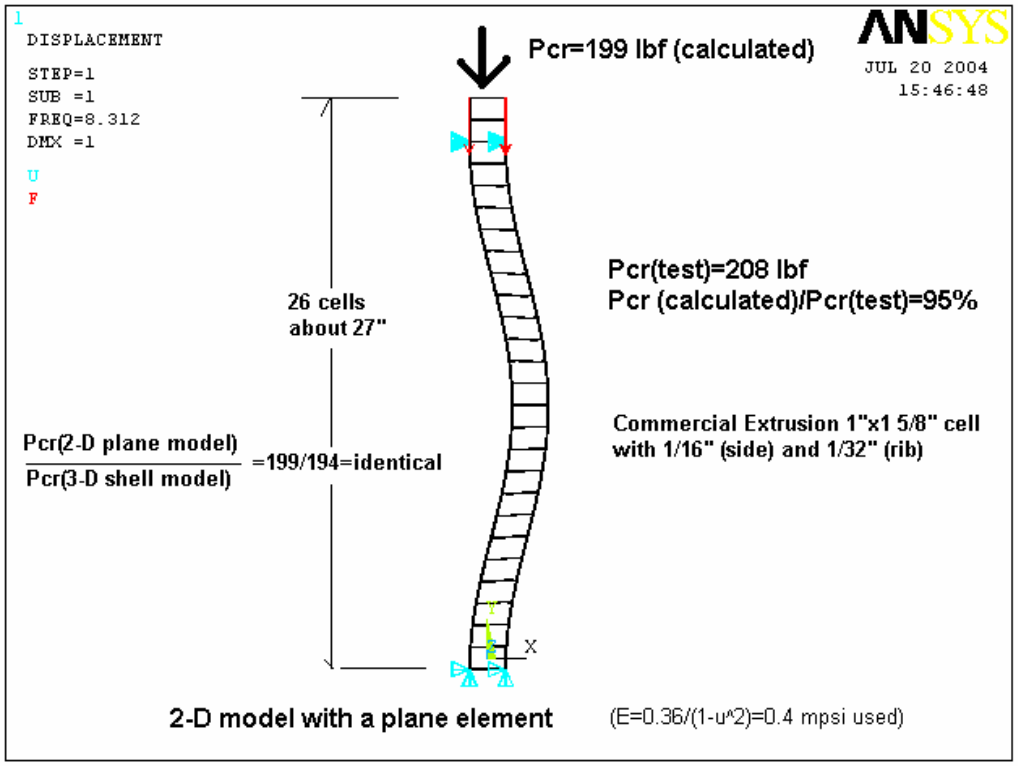

Figure 2 A 2-D finite element model with a plane element

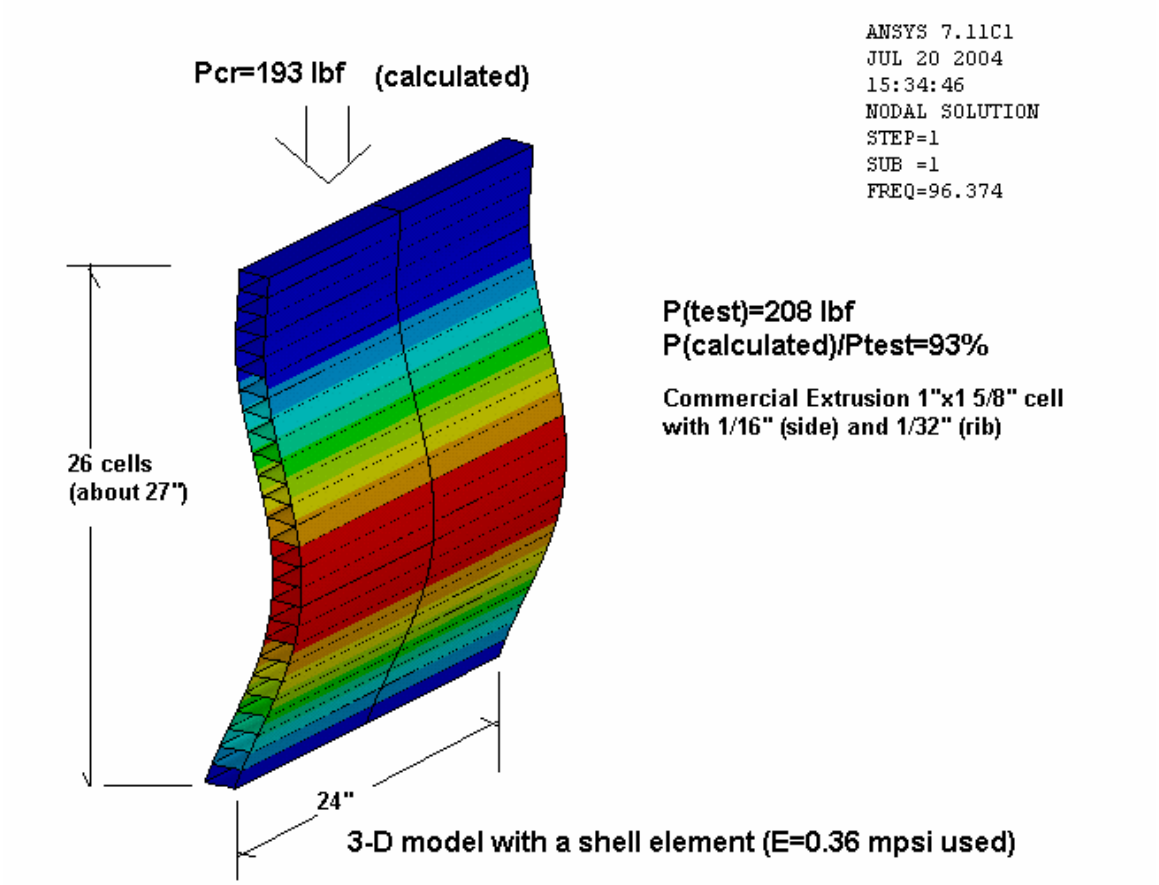

Figure 3 A 3-D FEA model with a thin shell element

Analytic Solution:
Based on "Theory of Elastic Stability" by Timoshenko & Gere, 2nd Edition, pp 138 – pp139, Column with Batten Plate

The equation (2-63) is modified for a fixed end boundary condition and 24" length a

$$P_{cr} = \frac{4\pi^2 EI}{l^2} \frac{1}{1 + \frac{4\pi^2 EI}{l^2}\left(\frac{ab}{12EI_b} + \frac{a^2}{24EI_c}\right)} * 24"$$

By substituting
$E=0.36e6/(1-u^2)=0.4e6$ psi; $I=1.625^3/12=0.3576$; a=1" and b=1.625";
$I_b=(1/32)^3/12=2.5431e-6$; $I_c=(1/16)^3/12=2.03e-5$;
Then, above equation gives

P*cr*=173 (lbf)

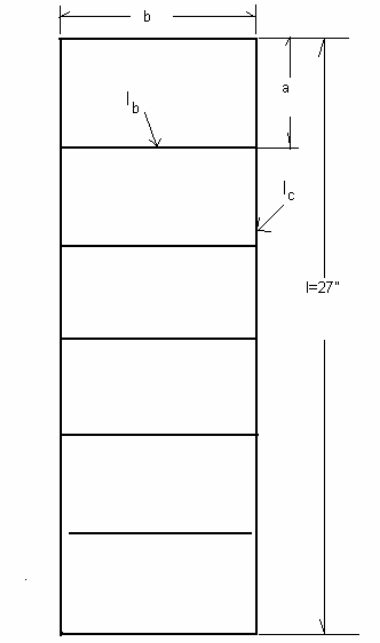

Figure 4 The sketch for an analytic solution